# Special Civil Engineer Examination
# Seismic Principles Test Plan
***Revised December 2000***

***Definition of Seismic Principles***

**Seismic Principles** is defined as the fundamental principles, tasks, and knowledges underlying those activities involved in the California practice of seismic design, seismic analysis, or seismic evaluation of civil engineering projects such as:

- buildings (new, retrofit, etc.)
- non-building structures (tanks, towers, etc.)
- bridges and other infrastructures (tunnels, pavement, etc.)
- lifelines (water, sewage, gas, power, communications, etc.)
- earth structures (dams, retaining structures, slope stability, etc.)

This area of practice is structured into five primary content areas. The percentage given in parentheses represents the proportion of total test points that will address that test plan area.

A. Seismic Data and Seismic Design Criteria (27%)
B. Seismic Characteristics of Engineered Systems (24%)
C. Seismic Forces (20%)
D. Seismic Analysis Procedures (18%)
E. Seismic Design (11%)

***Glossary of Seismic Principles Terms***

Please note that these abilities are arranged hierarchically from the least complex to the most complex. That is, **recognize** constitutes the least complex ability in the hierarchy and **perform** constitutes the most complex. Moreover, each ability presupposes all abilities preceding it in the hierarchy. For example, the ability to **determine** presupposes the abilities to **recognize** and **understand.**

As used in the test plan, the following abilities are defined as:

**Recognize** To know or identify seismic principles from past experience or knowledge.

**Understand** To recognize and comprehend seismic principles.

**Determine** To establish and define seismic forces or systems.

**Perform** To execute and complete a task in accordance with seismic principles.

***(*NOTE:** As used throughout this test plan, ***UBC*** refers to the ***1997 Uniform Building Code**.)*

## A. SEISMIC DATA AND SEISMIC DESIGN CRITERIA (27%)

Tasks required for the development of the project seismic design methodology considering the effects that the seismic environment has on the civil engineering project.

**SA1 Understand earthquake data that influence design of projects.**

SA1.1 Knowledge of earthquake characteristics and terminology (e.g., epicenter, focal depth, types and activity of faults)

SA1.2 Knowledge of historical earthquake activity in California

SA1.3 Knowledge of earthquake scales, including the Richter Magnitude*, moment magnitude* and Modified Mercalli Intensity

SA1.4 Knowledge of probability of occurrence of earthquake ground motion

SA1.5 Knowledge of earthquake accelerographs, response spectra, and ground acceleration

**SA2 Understand geotechnical issues that may influence design of projects.**

SA2.1 Knowledge of geologic seismic hazards and geotechnical data that affect design, including liquefaction, slope stability, settlement, and faulting

*SA2.2 Knowledge of UBC soil profile types, seismic source types, near source factors, and seismic response coefficients.*

SA2.3 Knowledge of soil-structure interaction, including the effective natural period of the structure and the expected period of the seismic ground motion

SA2.4 Knowledge of lateral seismic earth pressure on retaining structures

**SA3 Recognize design performance goals for a project.**

SA3.1 Knowledge of the seismic design philosophy of the *UBC*

SA3.2 Knowledge of seismic performance levels such as life safety, operational, fully functional

**SA4 Recognize laws, codes, and standards governing seismic design.**

SA4.1 Knowledge of the Practice Law, Responsible Charge Criteria, Practice Within Area of Competency

SA4.2 Knowledge of the Alquist-Priolo Earthquake Fault Zoning Act *and the Seismic Hazards Mapping Act*

SA4.3 Knowledge of the *UBC* and the California Building Code (CBC) for new construction

SA4.4 Knowledge of the Uniform Code for Building Conservation (UCBC), State Historical Building Code (SHBC), and tilt-up seismic strengthening ordinance for existing buildings

SA4.5 Knowledge of Caltrans Bridge Manual: Design Specifications

SA4.6 Knowledge of Structural Engineers Association of California (SEAOC) Blue Book Commentary, International Conference of Building Officials (ICBO) Evaluation Reports, and Applied Technology Council (ATC) publications.

## B. SEISMIC CHARACTERISTICS OF ENGINEERED SYSTEMS (24%)

Tasks required to select new seismic structural systems, to understand the methods of strengthening existing structural systems, to recognize the importance of seismic issues associated with lifelines, and to understand requirements for earth structures.

**SB5 Determine appropriate seismic resisting structural system.**

SB5.1 Knowledge of the different structural systems and their design parameters

SB5.2 Knowledge of performance characteristics of different structural systems (e.g., stiffness, ductility, damping, redundancy, redistribution)

SB5.3 Knowledge of influence of structural configuration on torsional response (e.g., plan irregularities, unbalanced resistance)

SB5.4 Knowledge of requirements for a structure having vertical irregularities (e.g., vertical discontinuities, offsets, soft stories)

SB5.5 Knowledge of drift and P-Delta requirements to control deflections

**SB6 Recognize seismic performance and damage vulnerability of structures.**

SB6.1 Knowledge of effects of ductility, damping, redistribution, and redundancy on seismic performance

SB6.2 Knowledge of the following types of construction with poor seismic performance

- unreinforced masonry (URM) bearing wall buildings (anchorage and stability of URM walls)
- pre-1976 concrete frames (non-ductile behavior)
- concrete bridges (non-ductile behavior)
- steel-braced frames (buckling or brittle connections)
- steel and concrete frames with unreinforced masonry (URM) infill walls (failure of URM walls)
- precast concrete structures (assemblies with weak connections)
- flat slab concrete structures (punching shear problems)
- tilt-up and masonry industrial buildings (diaphragm-wall connection problems)
- welded steel moment frames (welded connection problems)
- liquid filled tanks (sloshing and impulsive loading, tank buckling)

SB6.3 Knowledge of seismic performance of residential buildings with weak cripple walls, non-anchored foundations, pier/post foundations, and buildings with parking that creates a soft story

SB6.4 Knowledge of effects of overstress on seismic structural components or systems (e.g., stress-strain characteristics, damage characteristics, loss of system integrity)

**SB7 Understand methods for seismic strengthening of existing structures**

**(e.g., buildings and bridges).**

SB7.1 Knowledge of methods and effects of adding overall strength

SB7.2 Knowledge of methods and effects of adding stiffness to protect brittle elements

SB7.3 Knowledge of methods and effects of improving ductility of brittle elements

SB7.4 Knowledge of methods and effects of reducing building mass

SB7.5 Knowledge of methods and effects of strengthening weak-links (elements or connections) in structural systems

SB7.6 Knowledge of base isolation

SB7.7 Knowledge of supplemental damping systems

**SB8 Recognize the seismic requirements for lifelines.**

SB8.1 Knowledge of the earthquake design requirements for lifeline systems such as power, communications, natural gas, liquid fuels, water, and sewage systems

SB8.2 Knowledge of redundancy requirements for lifeline systems

**SB9 Understand the seismic requirements for earth structures.**

SB9.1 Knowledge of seismic loading for retaining structures and tunnels

SB9.2 Knowledge of seismic requirements for landfills, cuts and fills, engineered grading, etc.

## C. SEISMIC FORCES (20%)

Tasks required for the determination of the seismic forces on engineered structures.

**SC10 Determine structural characteristics required to calculate seismic design forces.**

SC10.1 Knowledge of mass and stiffness

SC10.2 Knowledge of methods to determine the structure's fundamental period

*SC10.3 Knowledge of reliability/redundancy factor ρ*

**SC11 Determine *UBC* seismic design forces for buildings.**

SC11.1 Knowledge of *UBC* static force procedures

SC11.2 Knowledge of choice and application of *R and* $\Omega_o$ factor

SC11.3 Knowledge of *UBC* Design Base Shear *formulas*

SC11.4 Knowledge of the Vertical Distribution of the *UBC* Forces

**SC12 Determine seismic forces for elements of structures, non-structural components, and equipment.**

*SC12.1 Knowledge of UBC design seismic force,* $F_p$

**SC13 Determine seismic forces for non-building structures (e.g., tanks, towers).**

*SC13.1 Knowledge of choice and application of R and* $\Omega_o$ *factors*

*SC13.2* *Knowledge of UBC design lateral force formulas*

**SC14** **Determine seismic forces by the response spectrum method.**
SC14.1 Knowledge of *UBC* dynamic lateral-force procedures
SC14.2 Knowledge of modal response combination methods

## D. SEISMIC ANALYSIS PROCEDURES (18%)

Tasks required for the analysis of engineered structures

**SD15** **Determine the distribution of seismic forces to structural elements based on their rigidities.**
SD15.1 Knowledge of methods used to calculate rigidities of structural elements, including the effects of fixed, pinned, or semi-rigid member end conditions
SD15.2 Knowledge of distribution of seismic forces based on rigidity
SD15.3 Knowledge of diaphragm chord forces, drag forces, and diaphragm shear

**SD16** **Perform the seismic analysis of rigid diaphragm structures.**
SD16.1 Knowledge of assumptions controlling the analysis of rigid diaphragms
SD16.2 Knowledge of methods to determine centers of rigidity and mass
SD16.3 Knowledge of methods to distribute shear forces to structural elements
SD16.4 Knowledge of horizontal torsional moment requirements

**SD17** **Perform the seismic analysis of flexible diaphragm structures.**
SD17.1 Knowledge of assumptions controlling the analysis of flexible diaphragms
SD17.2 Knowledge of sub-diaphragm analysis

**SD18** **Recognize analytical methods that utilize computers.**
SD18.1 Knowledge of existence of structural frame and finite element analysis programs
SD18.2 Knowledge of purposes, scopes, and limitations of frame and finite element analysis programs

**SD19** **Recognize purposes of non-linear and inelastic analyses of structural systems.**
SD19.1 Knowledge of the difference between elastic/inelastic analyses and linear/non-linear analyses

## E. SEISMIC DESIGN (11%)

Tasks required for the design of structures, structural elements, and assemblies, and for the material detailing requirements necessary to assure seismic performance.

**SE20 Understand the detailing requirements that are critical for seismic performance.**

SE20.1 Knowledge of seismic detailing and inherent seismic performance characteristics for steel

SE20.2 Knowledge of seismic detailing and inherent seismic performance characteristics for concrete

SE20.3 Knowledge of seismic detailing and inherent seismic performance characteristics for masonry

SE20.4 Knowledge of seismic detailing and inherent seismic performance characteristics for wood

SE20.5 Knowledge of deformation compatibility requirements for non-structural elements and structural separations

SE20.6 Knowledge of drift requirements

SE20.7 Knowledge of requirements for horizontal and vertical seismic forces

SE20.8 Knowledge of requirements for ties and continuity, collectors or drags

SE20.9 Knowledge of requirements for anchorage of concrete and masonry walls

SE20.10 Knowledge of requirements for building separations

**SE21 Recognize the need for construction quality monitoring and inspection of the seismic design aspects of the project.**

SE21.1 Knowledge of construction materials (engineering properties, thermal properties, shrinkage, etc.)

SE21.2 Knowledge of construction requirements for the placement of materials for the lateral load resisting elements

SE21.3 Knowledge of testing, special inspection, and structural observation requirements